HDRI 3D

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Issue 8

DIGITAL ARTISTS BRING THE TIMELESS CLASSIC TO LIFE

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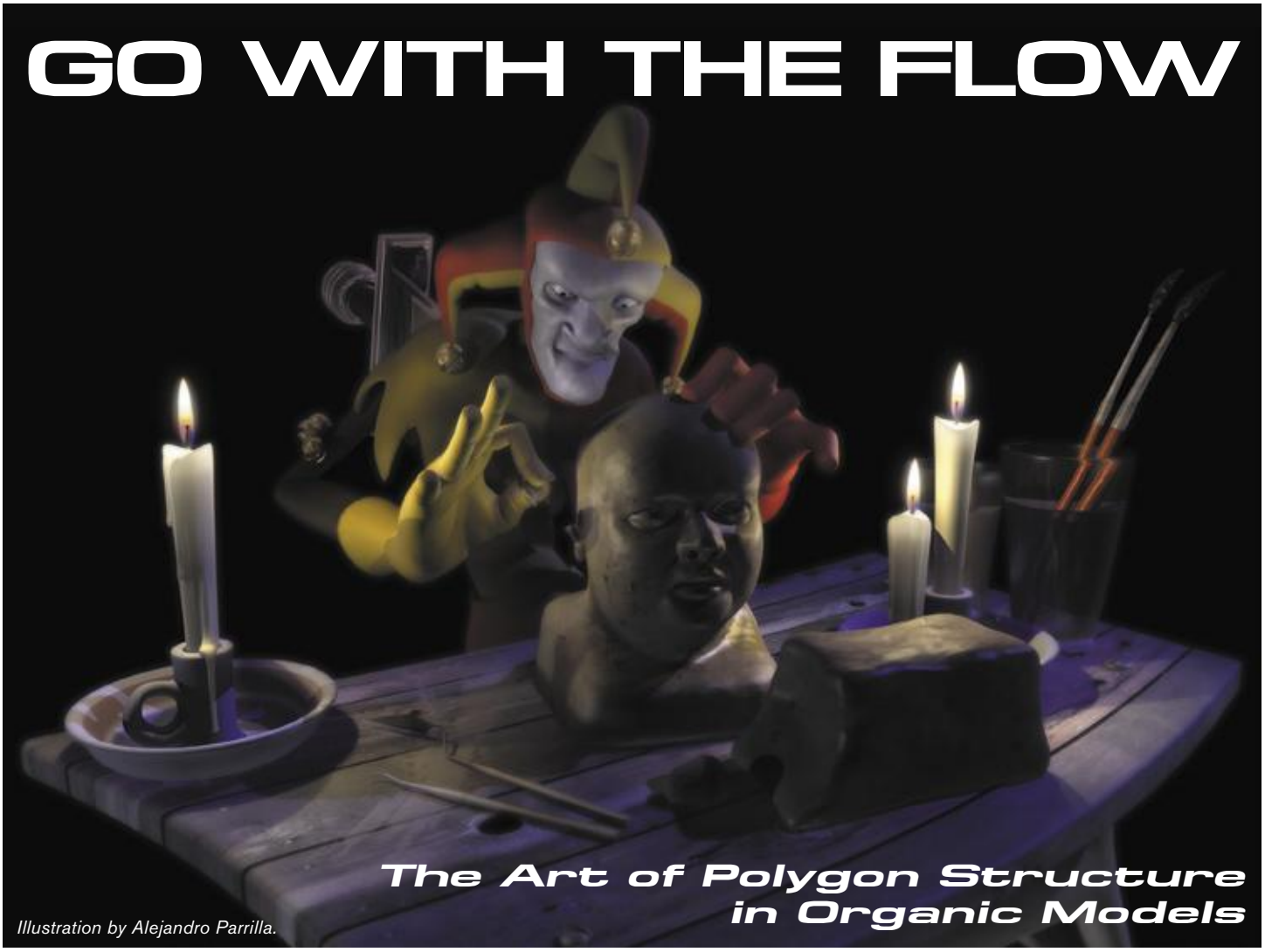
GO WITH THE FLOW



The Art of Polygon Structure in Organic Models

Illustration by Alejandro Parrilla.

William "Proton" Vaughan
3D Artist, Author, Teacher
Orlando, Florida

"Cleanliness and order are not matters of instinct; they are matters of education, and like most great things, you must cultivate a taste for them." *-Benjamin Disraeli*

Last year I packed up my family and moved to Orlando, Florida, right after three massive hurricanes hit, to teach at the DAVE School. When house shopping, I was very concerned about the stability of the houses I was looking at, knowing that harsh weather is common in Florida. I wanted to make sure the house I bought was built on a good foundation and with a good solid base structure. I found a great house that has weathered the storms over the past year and, though we have given the house a face-lift, the underlying structure remains problem-free.

Like a good house, 3D models should not only look good, they should also have a strong base structure on which deformations will take place. A complex animation of an organic object can be like a hurricane to a house. If a good structure doesn't exist, then your model will not hold up and problems will occur.

If you visit any online CG forum, you will see artists asking to see wireframe images of the models people post. This is mainly due to the fact that most 3D artists won't call a model excellent unless it has a solid structure underneath. In this article I hope to share with you some basic guidelines that should help give your organic models a strong base structure that can make surfacing, rigging, and animating much easier.

CLEANLINESS IS NEXT TO GODLINESS

It's easier to predict how an object will animate with clean geometry. "Clean geometry means artists down the pipe will run into fewer problems, compared to the artist who creates sloppy or heavy models," Nick Boughen, Rainmaker CG Supervisor explains. "Artists should always strive to use as few polygons as possible to achieve the modeling objective."

A simple mesh doesn't mean that you can't have the detail you need to get realistic organic models. Use only the geometry you need to get the detail you want and only have detailed geometry where you need it. I refer to this technique as having "localized detail." Let's use a head as an example. The face, which has complex mobile structures, including the eyes, nose, and lips, needs much more geometry than the back of the head, which has a much more simple and uniform structure with no parts that must independently move or deform. (See **figures 1–3**.)

The fewer polygons you have in your mesh, the easier it is to rig and animate. Fewer polygons equals fewer points. Fewer points equals less points to weight and assign to bones. "Also not to be underestimated is the ease of creating UV textures on a nice clean mesh," adds Jonas Gustavsson, LightWave developer.

Most game artists have mastered the art of clean models since they are limited as to the amount of polygons they can use for their game engines. Every polygon has to have a purpose, and any unneeded geometry is removed. We can learn a

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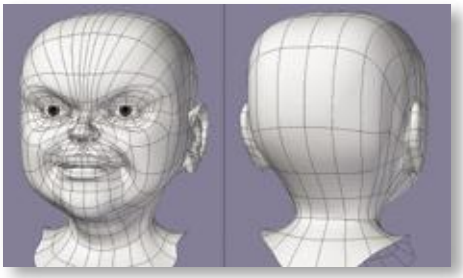

Figure 1–As mentioned, the face needs more geometry than the back of the head. Keeping areas like the back of the head simple will keep your mesh clean.

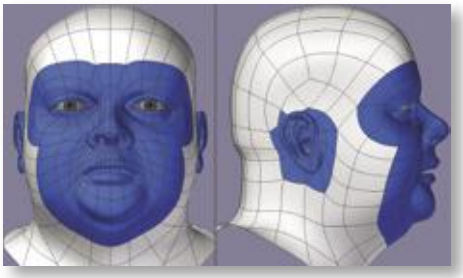

Figure 2–The face and the ears are areas that need more geometry than the rest of the head. The white areas on this head represent the areas of the head that can have a lower polygon count.

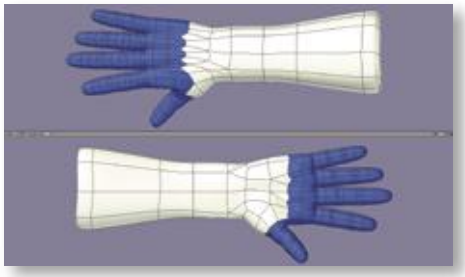

Figure 3–Hands can also have localized detail. Fingers will deform more than the base of the hand and forearm so they need more geometry. The white areas on this hand represent the areas that can have a lower polygon count.

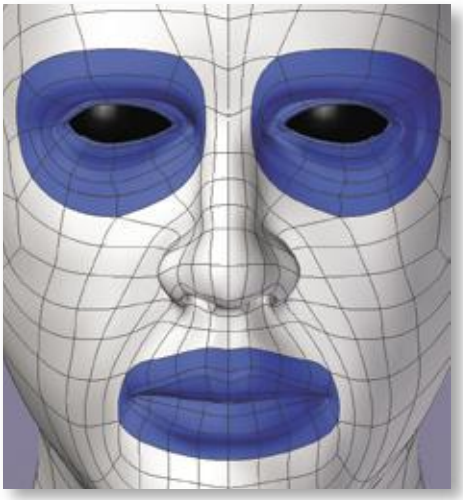

Figure 4–The blue areas on this face represent two common sets of edge loops on a face. The edge loops will help give a natural look to the eyes and mouth when deforming.

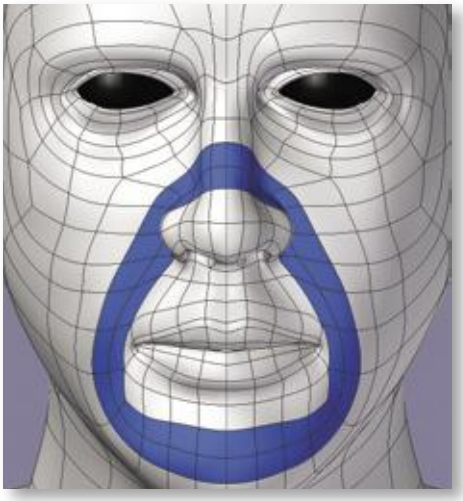

Figure 5–The areas in blue on this face show edge loops that are great in mimicking the laugh lines on a face. These can be very helpful when creating morph targets for the mouth area.

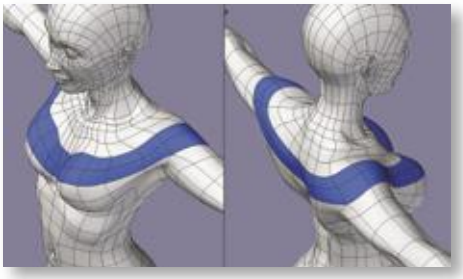

Figure 6–Edge loops are not limited to the face. Good edge loops in the body can make problems in areas like the shoulder a thing of the past.

Figure 7–Clean geometry with good polygon flow makes the creation of morph targets a simple task.

lot from this process even when we are working on higher polygon models. Use only the geometry you need to get the shapes you want. Keep your models simple and clean.

ARE YOU IN THE LOOP?

Polygon flow is a very common term used by 3D artists, but relatively few modelers have clean poly flow. “When doing animation, the last thing an animator needs to worry about is how the model will hold up under any given situation,” Richard Lico, Animator at Monolith, informs us. ”Granted, point weighting plays a huge role in games, but a model with the proper poly flow will be able to handle more dramatic deformations with minimal weight revisions.”

Edge loops are bands of polygons in a mesh that mimic real muscles and can become the most powerful tool in your modeling arsenal for good poly flow in organic models. “It’s important that we make models as easy to read, select, and manipulate as possible, and edge loops serve a very important purpose in that goal,” comments David Ikeda, LightWave developer. (See **figures 4–6**.)

Just like fewer polygons, good poly flow makes it easier to rig and animate. Creating morph targets on faces with proper edge loops is a simple task (**figure 7**), and when applied during animation they will look

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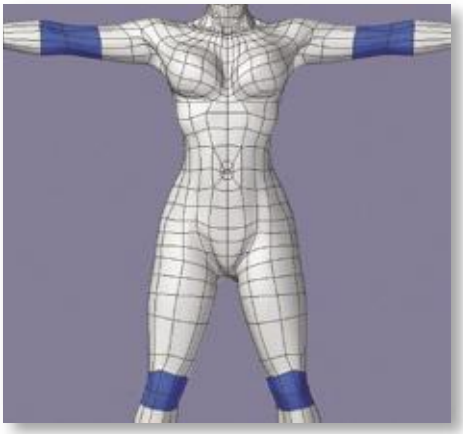

Figure 8–The sets of edge loops that make up the elbows and knees consist of three segments per set. The middle segment is where the bend will take place, and the outer segments keep the outer areas from unwanted deformations.

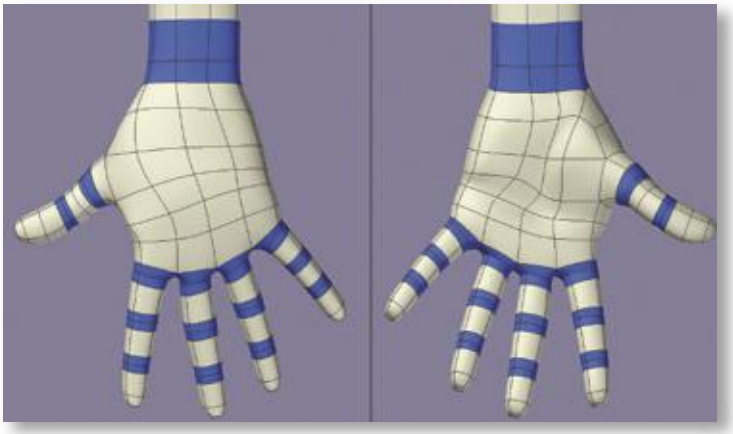

Figure 9–Three segments per joint in the hand and wrist helps keep the shape of the hand during animation. Without the proper amount of segments, fingers can lose structure and appear to bend like a water hose.

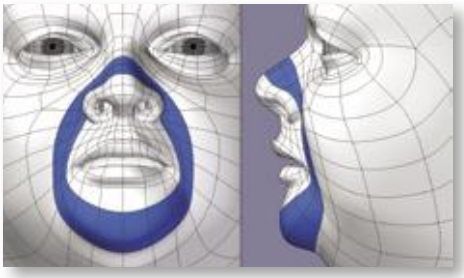

Figure 10–The three segments in the laugh lines on the face allows the middle segment to create the crease while the outer segments hold the shape of the cheek and lip areas.

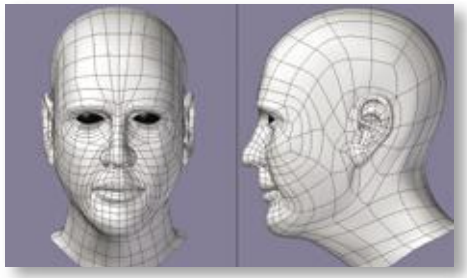

Figure 11–This human head consists of 1078 four-point polygons.

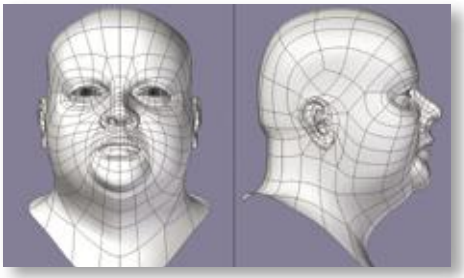

Figure 12–This human head consists of 1290 four-point polygons.

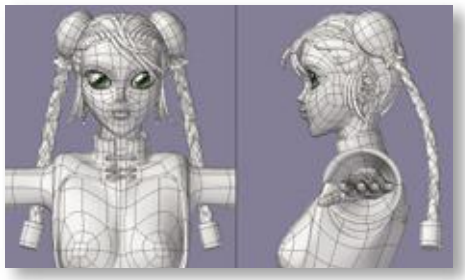

Figure 13–The entire anime girl model consists of 6554 four-point polygons. Note: Only a portion of the model is shown in this image.

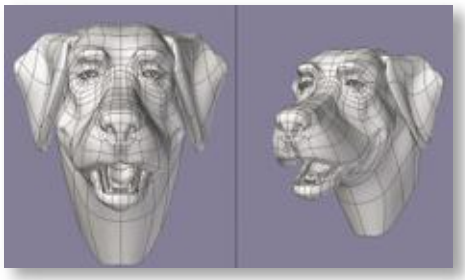

Figure 14–This dog head model consists of 1650 four-point polygons.

more natural. "Good poly flow means bone and morph target deformations will work and stretch as expected," affirms Nick Boughen.

One thing to keep in mind is that although loops are great and you want to have enough to get the shapes you want, be careful not to have too many loops. Too many loops can cause pinching and unwanted creases in your object. "Using the right amount of loops can be tricky when you are first getting into modeling, but the more models you animate the easier it will be for you to judge how many to use," notes Kurt Larsen, IGT artist.

THE POWER OF THREE

Areas on a model that will have heavy deformations need an underlying structure that will support the shapes you have defined. Although there are always exceptions to the rule, it is a good idea to use three segments in areas that will deform heavily (**figure 8**). *Note:* The three segments are the boundaries of two bands of polygons. The middle segment is where the deformation will take place, and the segments on either side support the mesh beyond the deformation. Example areas for using the power of three would be elbows, shoulders, knees, finger joints, wrists, and even laugh lines on faces (**figures 9** and **10**).

"I used to fight areas like shoulders and hips when rigging and animating characters, until I applied three segments to those areas," remarks Alejandro Parrilla, animator, "Now I feel I can predict how those areas will deform with just a quick survey of the mesh."

Remember that although three segments can be the solution most of the time, all objects are different. The number of segments depends on the type of deformation you want to achieve. Too many segments or loops can cause pinching in your mesh, as discussed above.

FOUR POINT PERFECTION

I'm going to try and tread lightly here as this is a topic of much debate with artists, and as mentioned above, there are always exceptions to the rules.

When modeling areas of heavy deformation, you will get much better results if you stay away from three-point polygons and instead use four-point polygons. Three-point polys tend to cause pinching and strange smoothing errors in most cases. While you can get away with that in certain lighting situations or camera setups, it is good practice to have your models deform nicely no matter what type of lighting or camera placement you may be working with. (See **figures 11–14**.)

N-gons, polygons with more than four points are also known to cause pinching

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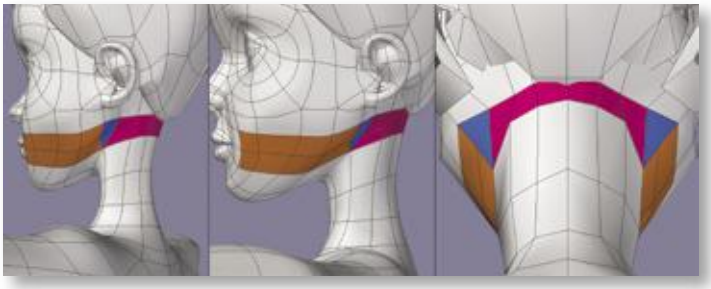

Figure 15–To reduce the polygon count on the back of the neck of the character, a four-point triangle was used.

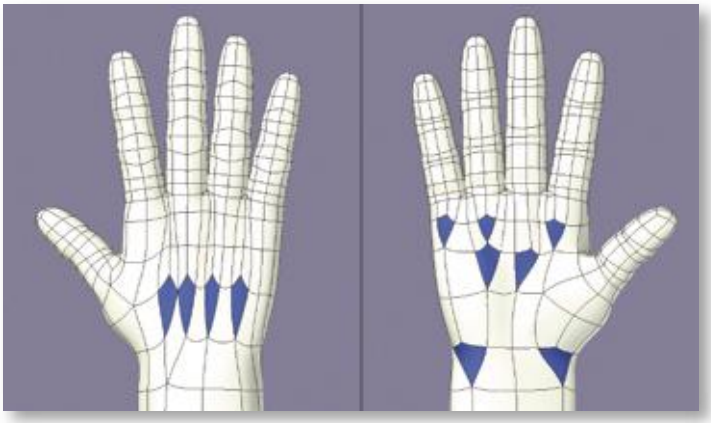

Figure 16–Diamond four-point polygons were used instead of three-point polygons to reduce the amount of geometry that ended up in the wrist of this hand.

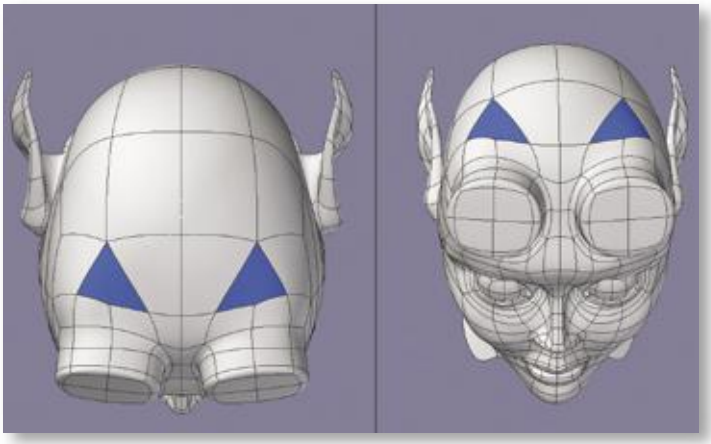

Figure 17–To reduce the polygon count for the back of this demon's head, two four-point triangles were used.

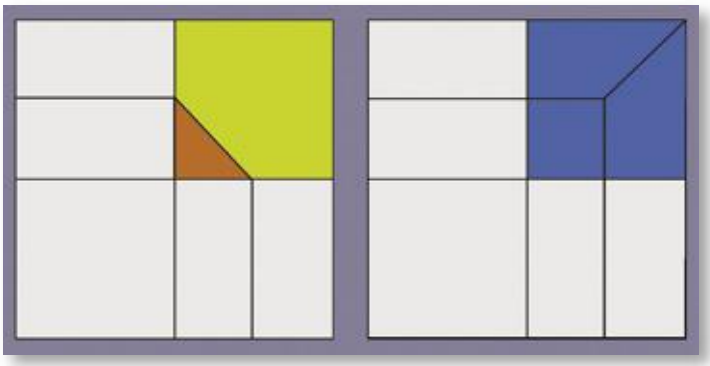

Figure 18–The polygon flow on the left shows the use of a three-point polygon and a five-point polygon. The image on the right shows the use of all four-point polygons in the same area.

and smoothing errors in areas with heavy deformation. Four-point polygons are also known as quads. "Working exclusively with quads should be the goal of every character modeler. Even though LightWave 9 supports subpatched n-gons, I'd recommend avoiding their use if at all possible. Quads are just superior," comments Steve Warner, author of *LightWave 3D 9 Modeling–A Definitive Guide*. "They allow the formation of distinct loops (which can mimic major muscle groups and produce more realistic-looking characters). They also create more predictable deformations in facial animation and posing."

One reason artists may use n-gons or triangles is to try to reduce the polygon count in areas that don't need as much detail, like the back of a head. If you choose to use n-gons or three-point polygons to help reduce geometry, try to use them in areas that won't deform or won't be in plain sight. This will reduce the chance of them showing up in your animation.

If you choose to use all four-point polygons, you can use a technique I have used for years with much success. I call it "Four-Point Triangles." I've also seen artists refer to them as "Pole Polygons" or "Diamond Polygons." These "four–point triangles" not only help reduce poly count but they can help define edge loops within your mesh. (See **figures 15–18**.)

Clean models with great polygon flow should be every modeler's end goal. Whether it will be you rigging and animating the model, or someone on your team, make the job easier by providing the most proficient structure possible.

"Bad flow, unnecessary use of triangles or n-gons, and excessive numbers of polygons are pitfalls that all modelers should avoid, especially character modelers," adds Steve Warner. "You can get away with a disjointed rat's nest of a mesh if you're just rendering a still. But if your model is going to be animated (especially with bones), those pitfalls will come back to bite you. The cardinal rule of modeling is two-fold: "Less is always more, and use four-point polygons."

I hope this article at least gets you thinking about polygon flow in your next model. Keeping it simple and clean means less work for everyone and more time for you to work on your next creation.

"Everything should be made as simple as possible, but not one bit simpler." - *Albert Einstein*

*A recipient of several New Media Addy awards, **William Vaughan** has an extensive background in creative 3D for print, web, multimedia, games, and broadcast. During the last 10 years, he has delivered award-winning work for clients such as Compaq, New Line Cinema, and Halliburton. William has also trained artists at several studios and schools around the world and contributed to six LightWave 3D books throughout 2003 and 2004.*

In 2002, Vaughan joined NewTek's marketing team as the LightWave 3D Evangelist, working closely with the LightWave development team, key accounts, and the growing number of end users to enhance LightWave's features set.

William is Director of Industry Relations and Instructor of The DAVE School's upcoming Final Project. William's focus is on continuously improving the quality of education at The DAVE School, while further establishing the school's presence in the industry.

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